Space Weather Technical Forecast

Issued on Wednesday, 26 January 2022 at 00:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance G1/Minor Geomagnetic Storm, mainly Days 1 and 3 (26th and 28th). Slight chance throughout of M-class flares. Chance of Active fluence.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low in the past 24 hours with several C-flares, peaking C9.9 at 25/2349 UTC from a region over the northeast limb. There are four regions currently on the visible side. AR2935 just west of north centre disc, was the source of a B8-flare and associated filament lift with CME around 25/0220 UTC, but has shown little development since. AR2936 near the northeast limb has given a minor flare. AR2934 has remained inactive in the southeast quadrant. AR2937 in the southeast quadrant developed over the last 24 hours, and is continuing to develop further. The CME which lifted from near AR2935 has been assessed as likely passing over the Earth, but with a chance of a glancing arrival around 29/0000UTC +/- 9 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was indicative of the glancing influence of a CME until 25/0400 followed by the CIR region ahead of CH46/+ and a transition into the subsequent high speed stream. Wind speeds were initially slow, but have been increasing since 25/0400 UTC, reaching near 500 km/s. The density has been mainly above average, with a peak of 65 ppcc at 25/0407 UTC. Total Interplanetary Magnetic Field (IMF) strength, Bt, has been weak to moderate, peaking at 13 nT, but has eased to become weak since 25/1730 UTC. Bz has varied between +10/-9 nT, but has been more often southwards directed. The phi angle has been quite variable but generally positive (away from Sun). Despite this geomagnetic activity remained generally Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), was at background to moderate levels. Electron fluence started above the 1e8 Active threshold, but showed a sharp drop after 25/1200 UTC, with 5.9e6 integrated pfu measured at 26/0000 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to remain Low, with four active regions on the visible disc, and potentially two further regions likely to rotate on. There is a slight chance of M-flares.

Solar Wind / Geomagnetic Activity: The current enhancement from the fast wind of CH46 is expected to continue early Day 1 (26th), before very gradually easing, although there is the potential for a weak glancing impact early in this period from a CME from a filament eruption on 22/0630UTC. The next notable enhancement will be from the arrival of the fast wind of CH47, either late Day 2 or on Day 3 (27-28th), with the potential for another weak CME to glance across Earth late on Day 3. This is currently considered more likely to miss however, with only a very slight chance of impact. Quiet to Active conditions at first on Day 1, with a slight chance of isolated G1/Minor Storm intervals mainly if we see an influence from the passing CME. Activity is

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then expected to be Quiet to Unsettled, before increasing again to Unsettled to Active with a slight chance of G1/Minor Storm intervals with any fast wind arrival or CME influence mainly on Day 3.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at background levels. The high energy electron flux (greater than 2MeV) is currently at background to moderate levels, and likely to persist as such, perhaps peaking briefly at High levels once the current coronal hole solar wind enhancement eases. There is a slight chance of more persistent High flux redeveloping. The associated 24hr electron fluence is currently below the Active (1e8 integrated pfu) threshold, with any further Active fluence dependent upon more persistent flux returning from later on Day 1 (26th).

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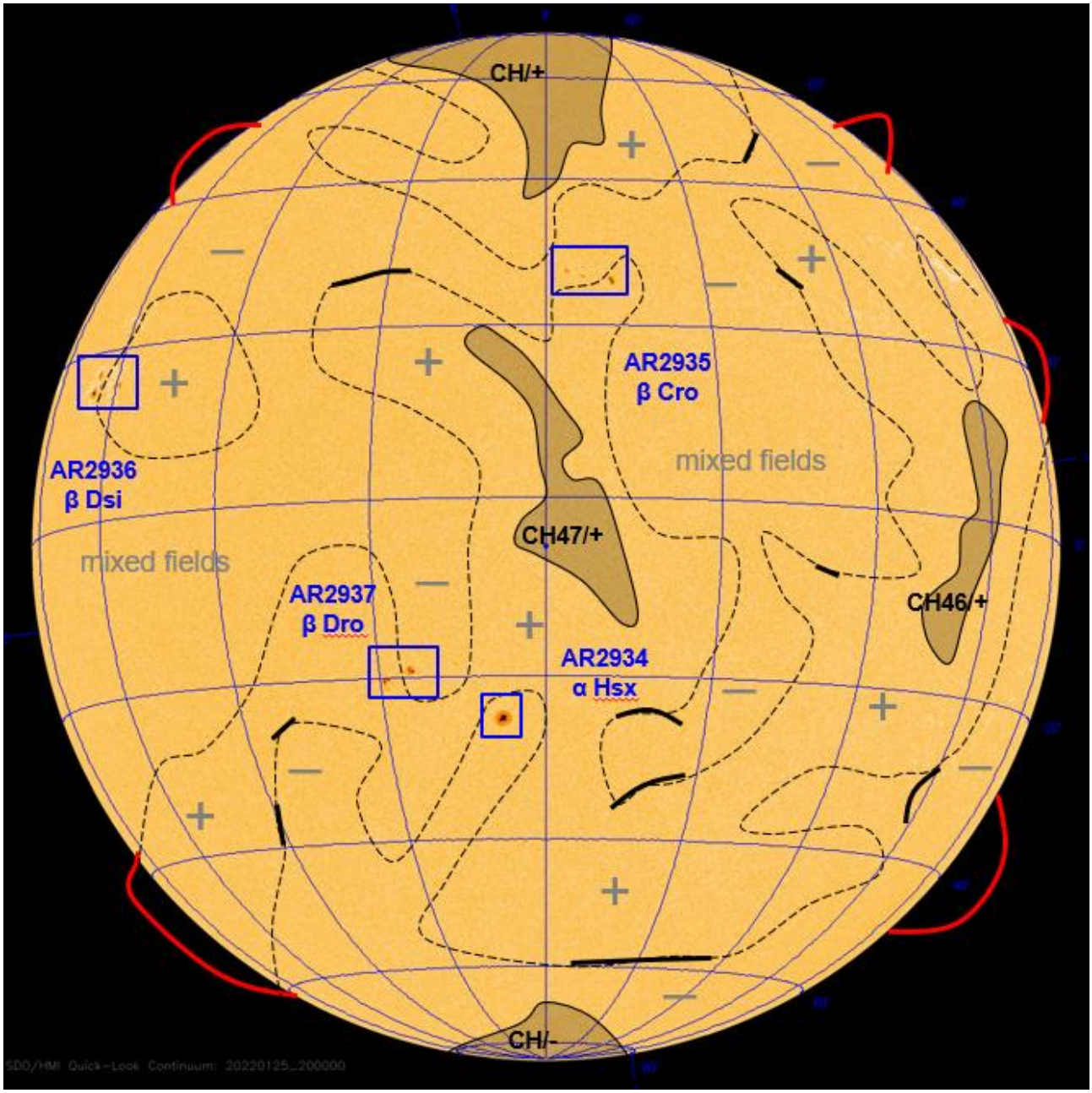
Figure 1. Solar Analysis Valid 25/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two CMEs that have the potential for glancing influence at Earth, however these are both low confidence. The first is from a filament eruption on 22/0630 UTC, which is estimated to arrive at Earth at 26/0000 UTC +/- 12 hours, but with notable uncertainty on how much influence will be seen at L1. A further CME was observed, potentially from the B8-flare of AR2935 and associated filament eruption at around 25/0220 UTC. Whilst centrally located on the disc, this is expected to miss passing to the north of the Earth around 29/0000UTC+/- 9 hours, but again with a slight chance of glancing impact. Neither of these CMEs are expected to have a noticeable impact on solar wind speed.

Solar winds are currently enhanced due to the fast wind of CH46. Earth appears to have moved through a weak CIR region and into the main fast wind, with solar wind speeds just below 500km/s, and these are likely to ease somewhat through Day 1 (26th). A further fast wind from CH47 is then expected to arrive either late on Day 2 or on Day 3 (27-28th), with similar wind speeds to CH46.

Quiet to Active conditions at first on Day 1 (26th), with a slight chance of isolated G1/Minor Storm intervals mainly if we see an influence from the passing CME. Activity is then expected to be Quiet to Unsettled, before increasing again to Unsettled to Active with a slight chance of G1/Minor Storm intervals with any fast wind arrival or CME influence mainly on Day 3 (28th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	5	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/0630	Partial	Filament	N15 E20	400	26/0000 UTC	Possible glance
25/0220	Partial	Filament	N23 E01	376	29/0000 UTC	Likely missing but low chance glance

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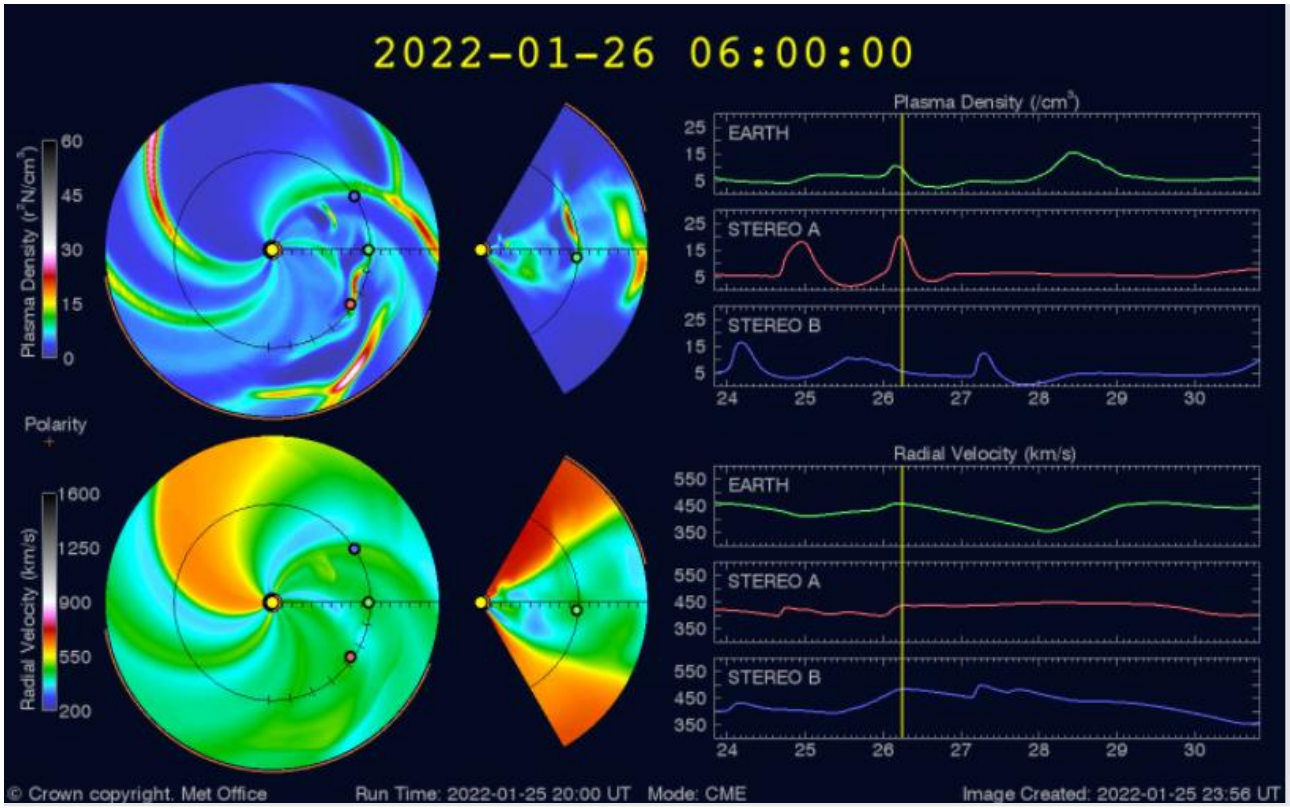
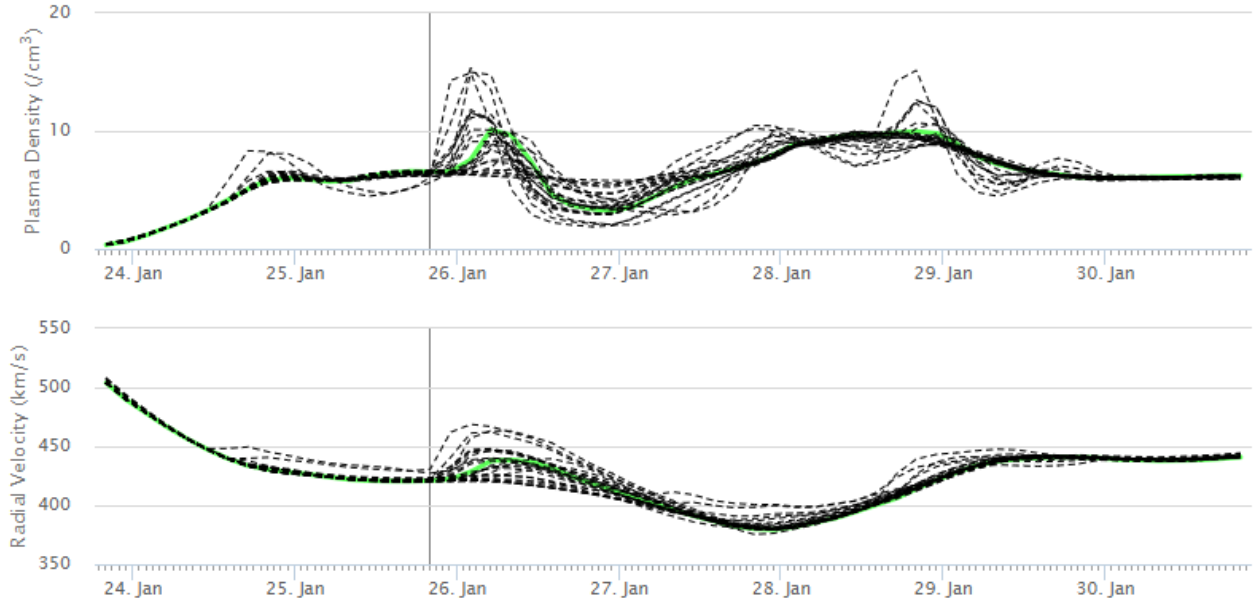
Figure 2: Enlil model and ensemble showing a possible CME arrival in the next few hours, and again a very slight chance around 29/0000 UTC.





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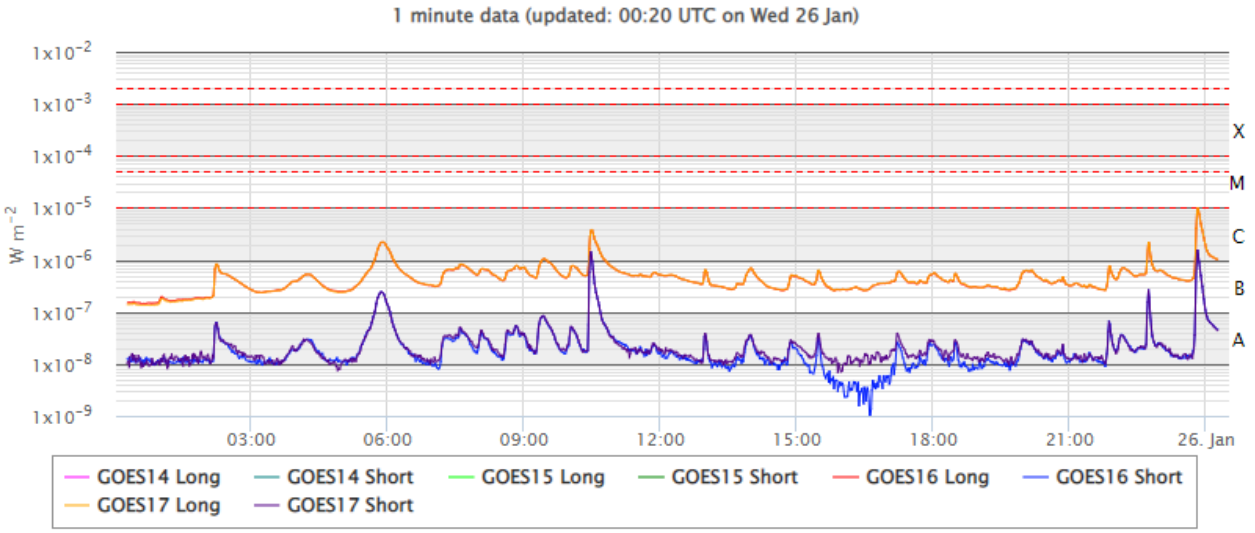
Radio Blackouts - X-Ray Flares:
Solar Activity is currently Low, with four active regions on the Earth-facing disc. The highest intensity flare, a C9.9 at 25/2349 UTC was from a region just over the northeast limb and hence is currently not properly visible. This is identifiable as a bright region on STEREO A euvi imagery, however.
Of the Earth-facing regions, AR2935 Cro/Beta in the north-centre disc was a likely source of a B8 flare at 25/0220 but appears to have stabilised since this flare, with no further notable growth. AR2936 Dsi/Beta has given a minor C-flare, however it has the most magnetic flux energy available of all the visible regions. AR2937 Dro/Beta has developed rapidly in the last 24 hours, and continues to develop, looking likely to become a more complex region. The final numbered region AR2934 is a mature Hsx/Alpha spot that continues as an inactive region.
Alongside the flaring region over the northeast limb mentioned above, another bright flux area is visible in the southeast on STEREO A euvi imagery, from just over the limb. These regions, alongside any further potential development of the above sunspots give a slight chance of M-flares (R1/R2 Radio Blackout), but otherwise Low activity is expected with C-flares likely.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	15	15	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: X-ray trace showing recent C9.9 flare



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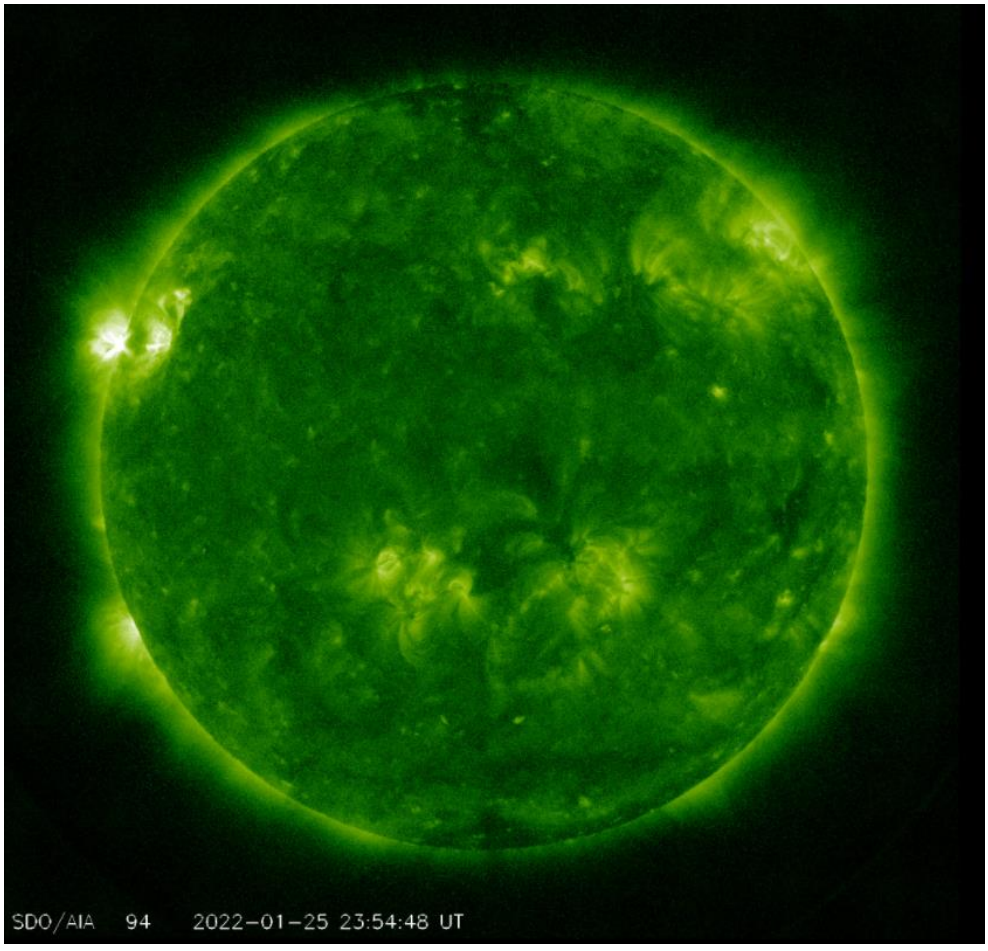
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux, as measured by GOES-16 is at background levels. No solar radiation storms are expected in the period, with the sunspots on the west of the Earth-facing side of the Sun all currently considered unlikely to give large flares.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: AIA-94 imagery showing recent C9.9 flare from over the northeast limb. This region is unlikely to give proton enhancements until it reaches a more westerly location on the visible disc.



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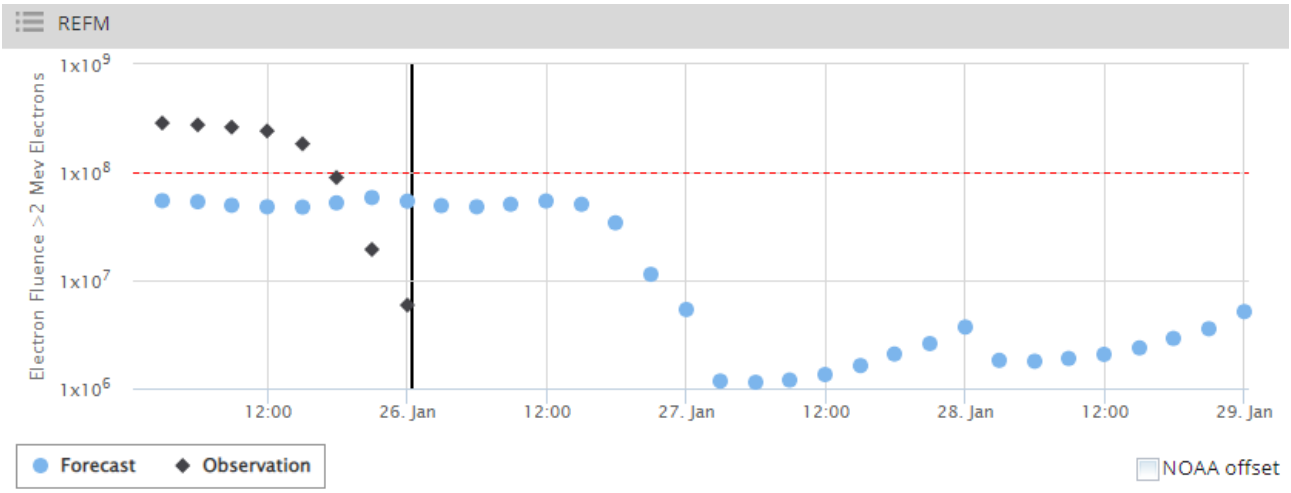
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO is currently at background to moderate levels, having dropped out due to the arrival of a glancing CME on the 24th, followed by a CIR ahead of the high speed stream from CH46. The potential for a further glancing CME arrival early on Day 1 (26th) will also prolong the dropout of values at GEO, should this occur. Whilst electron flux levels are expected to recover a little as any initial geomagnetic enhancement subsides, this is most likely to reach moderate levels, perhaps with peak High flux, with only a chance of returning to more persistent High levels. Flux levels are likely to drop again on Day 3 (28th) due to the arrival of another fast wind from CH47, and the slight chance for another CME glance.

The associated 24 hour fluence has fallen very sharply below the Active level in the last 12 hours. A chance of further Active fluence then becomes possible through the period, either from a further gradual build of levels as the forthcoming fast wind enhancement to the solar wind eases, or from the low chance of high flux levels being maintained and seen at GEO as the radiation belts de-compress. REFM is currently giving poor guidance, as this is not taking account of the current fast wind enhancement that is occurring, or any subsequent CME arrivals.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	10	30	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: Sharp drop off in electron fluence over the last 12 hours after the CME/CIR arrivals. REFM is unlikely to be giving good guidance at the present time however, as it won't take into account any CMEs in the forecast.



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